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AUTOMATIC ANALOG COMPUTER CONTROL BY MEANS OF  
PUNCHED CARDS - "CRESSIDA I" 2\*

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AUTOMATIC ANALOG COMPUTER CONTROL BY MEANS OF  
PUNCHED CARDS -- "CRESSIDA I"

by

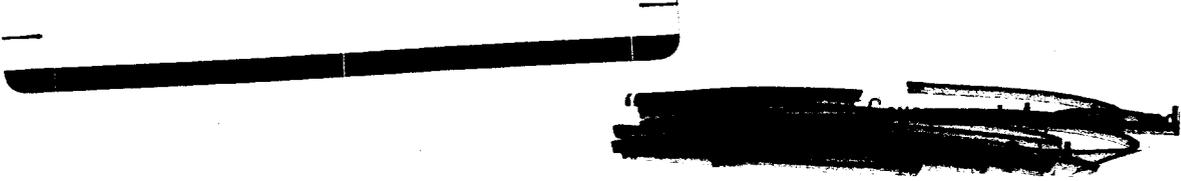
Armand VAN WAUVE

CETIS Report No. 46

April 1962

Analog Computation

Digital Computation



## FOREWORD

Within the framework of the CETIS project for coupling analog and digital computers in a single system, the stage of static coupling has so far been represented by the automatic digital processing of the physical equations for direct analog insertion. /2

This processing, the "abstract" input medium for which was the APACHE code punched on cards and passed through an IBM 7090, provided a listing of the equations analyzed.

A compilation of the results was required in order to introduce:

-- the corresponding numerical values (by means of ADIOS punched tape);

-- patchboard connections (by manual operation).

The present report describes a system which will make it possible to automate these two operations; this involves transforming an IBM 026 card puncher to allow punched-card input and output on an ADIOS console.

The system functions as follows:

1°) an APACHE output listing will be transferred to punched cards after automatic code conversion, the compilation of the results being suppressed. The automatic setting of the coefficients is immediate. The patchboard connections will be realized semi-automatically once the SATANAS system with the same modified IBM 026 as an input, has been built.

2°) The analog computer can be interrogated in the Static Test by a pre-established punched-card program, and the ADIOS - 026 combination also furnishes the answers on cards, thus suppressing all compilations and making the numerical and patchboard checks extremely rapid.

Thus, there is no need to insist on the importance of this arrangement, which is already functioning satisfactorily, for maximum efficiency and rapidity in problem handling, and for the incorporation of reversible static coupling within the broader program of dynamic coupling.

A. Riotte

## SUMMARY

### FOREWORD

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#### 2. DESCRIPTION

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5.3. CRESSIDA II

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AUTOMATIC CONTROL OF ANALOG COMPUTERS BY  
MEANS OF PUNCHED CARDS

(Conversion of the ADIOS and the IBM 026)

Project CRESSIDA I (Couplage REversible Statique  
Digital Analogue: Analog-digital reversible  
static coupling) [ref. 1]

1. INTRODUCTION

In the standard equipment of EAI analog computers, the numerical input is the ADIOS (Automatic Digital Input Output System) console which comprises an IBM-Electric typewriter and a tape reader and punch. /3

Given the evolution of the digital -- analog coupling projects as a whole, and in particular the processing of the APACHE code on the IBM 7090, for which the customary information-bearing medium is the punched card, it was also reasonable to envisage a card-fed input and output system for the analog installation.

Here we describe how this conversion was achieved: the ADIOS console was linked with an IBM 026 card punch, modified so that the 026 - ADIOS combination formed a unit capable of both reading and inserting analog quantities on cards.

This arrangement has the advantage of leaving each component all its inherent possibilities, while at the same time allowing them to function in combination: this is why the 026 system will still be available as an ordinary card punch, while the ADIOS manual commands remain effective. A combined system has now been achieved which concretizes and automates the first stage of static coupling made possible by the existence of APACHE II language [ref. 2].

The digital installation here comprises a large-capacity IBM 7090 (Fig. 3), an auxiliary IBM 1401 (Fig. 4) functioning as a punched-card input and output for the 7090, and an IBM 1620. Only the first two machines are involved in the static coupling.

The analog installation comprises two "Electronic Associates" [EAI] PACE 231 R (Fig. 2), one ADIOS and one IBM 026 card punch linked with ADIOS and capable of reading and punching cards in ADIOS code.

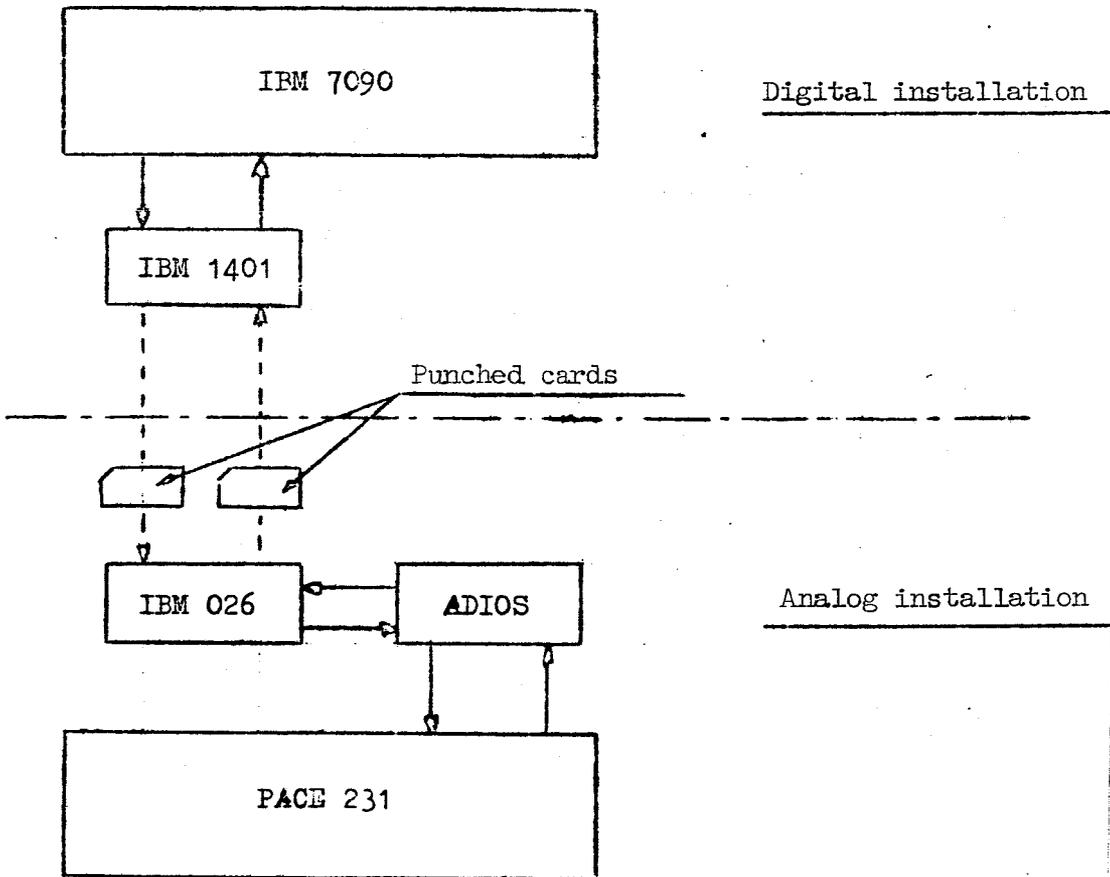


Fig. 1. Principal block diagram of punched-card static coupling.

## 2. DESCRIPTION

### 2.1. General Characteristics

#### 2.1.1. Input for card-fed analog computers

The IBM 7090 automatically performs a long series of operations prerequisite to the study of a problem treated on an analog computer

[ref. 2] and transmits to the IBM 1401 the information required for programming analog computers. Some of this information will be punched on cards in ADIOS code.

This information includes:

Operational modes for ADIOS.

Operational modes for computers.

Addresses and values of coefficients to be inserted automatically.

The S.T. (static test).

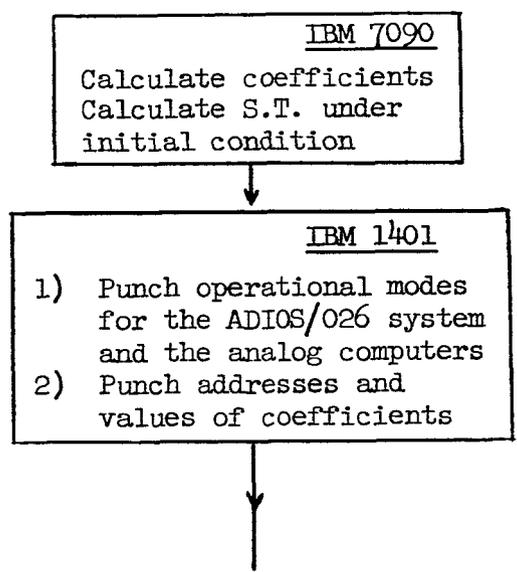
2.1.2. Output for card-fed analog computers

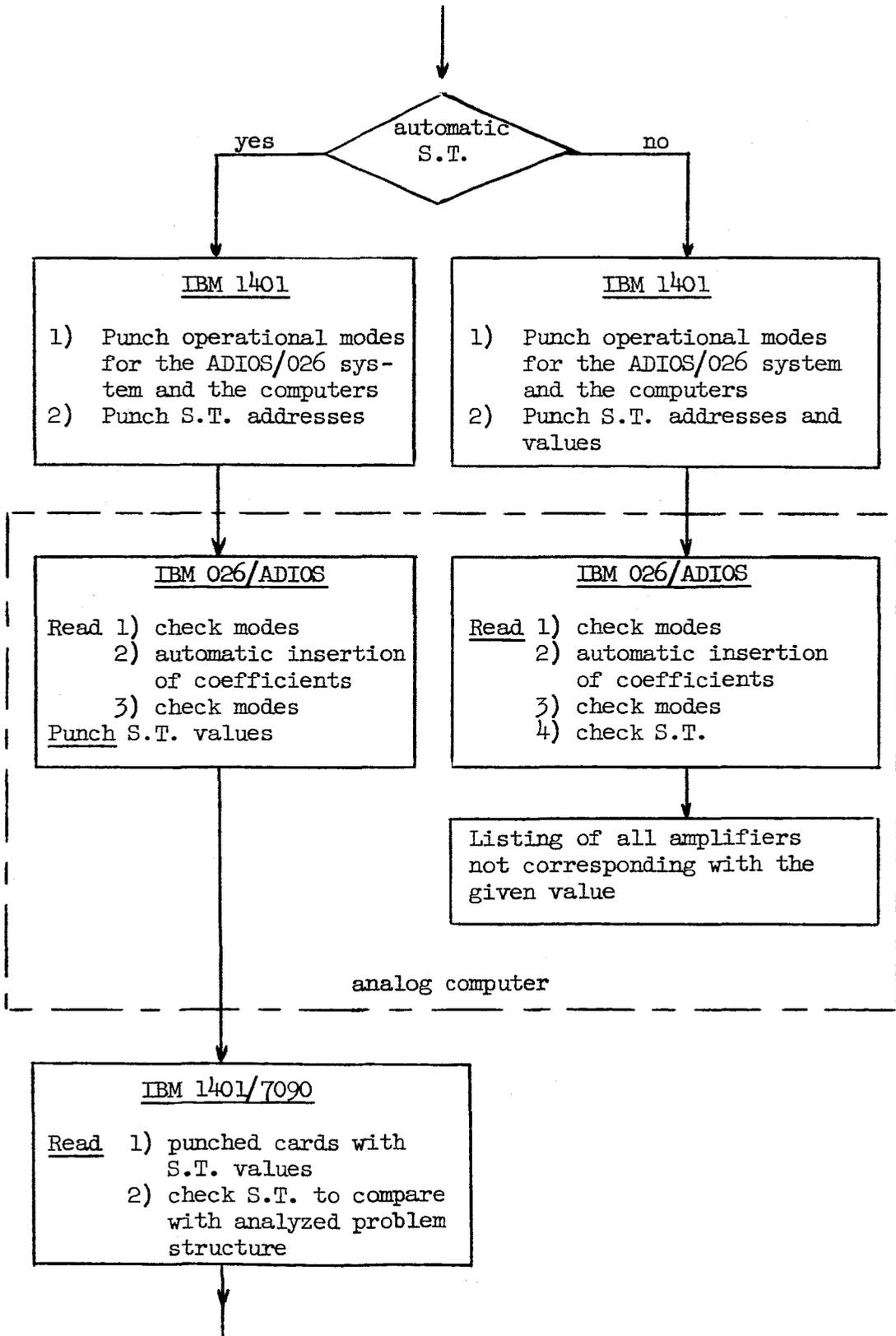
Punched cards for the S.T. interrogate the computers on the S.T. values, the values will be punched on cards in ADIOS code by the 026.

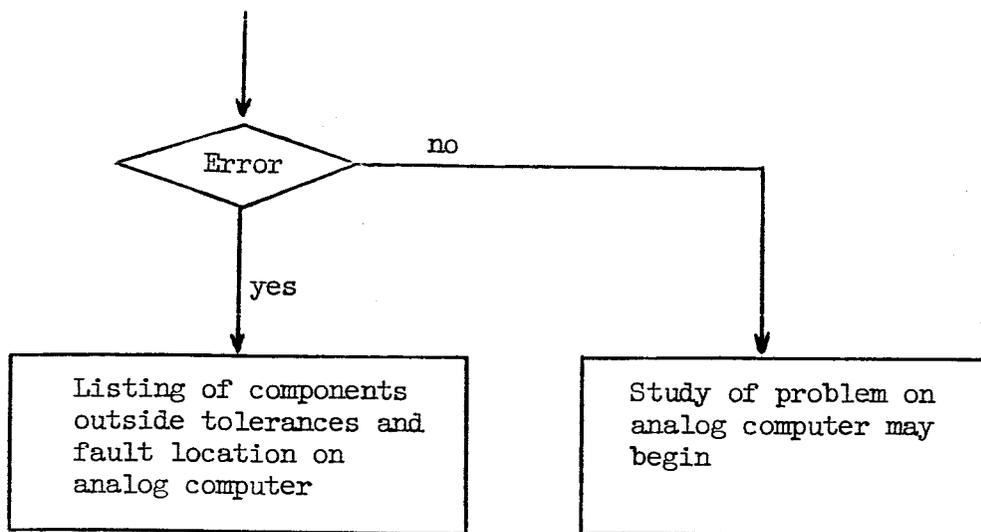
These cards will be read later by the IBM 1401 and the information will be transferred to the IBM 7090 where the Static Test will be verified.

2.2. Block diagram for automatic control

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### 2.3. The ADIOS/IBM 026 system

2.3.1. The ADIOS is employed to control the operations of the PACE model 231 R analog computers by means of tapes punched in ADIOS code, tapes punched in IBM 1620 code [ref. 3] or cards punched in ADIOS code, this last input-output of the system being a medium by far superior in performance to all others. The advantages gained thereby are enormous.

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Some of these advantages are as follows:

- a) Possibility of static coupling with the IBM 7090 (IBM 7090/1401 has an input-output for cards but not for tape).
- b) Code conversion is no longer required. (The IBM 7090/1401 accepts the ADIOS code by simple programming.)
- c) Ease in compiling a program for reading outputs of the problem treated, using a block of punched cards that only needs to be punched once. (When using tape, the entire program would have to be repunched each time to match the problem.)
- d) Ease in compiling test routines for maintenance.

There is no doubt that before long cards will be the only input-output medium in use.

2.3.2. Four principal functions of the ADIOS/IBM 026 system are:

- a) Selection and adjustment of potentiometers (setting coefficients) -- 300 units in our installation (cf. Fig. 8).
- b) Checking potentiometers (output).
- c) Reading and punching outputs of all elements which can be selected by the ERO (Extended Readout system).
- d) Checking computer modes.

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2.3.3. The ADIOS/IBM 026 combination includes:

- a) A drawer-mounted punched-tape reader (cf. Fig. 9) containing all the control keys as well as the keyboard and typewriter control circuits. The tape reader functions as one of the ADIOS inputs.
- b) A drawer-mounted tape punch containing the input and output distributors, the information storage circuits and the code control relays.
- c) A keyboard serves as a second system input, and is employed as a direct computer control or for preparing tape or punched cards.
- d) A typewriter which is an IBM-Electric model modified to receive information from ADIOS circuits. The typewriter is employed as a recording element and never controls the computers directly; it may, however, be occasionally used to prepare punched tape or punched cards.
- e) R.C.V.D. (Remote Control Voltage Divider), which is a reference digital-to-analog converter (D/A converter). This unit is installed behind the control desk and is used to set the potentiometers and as a reference for non-automatic static tests.
- f) IBM 026 punch. Originally used as a simple card punch in IBM code, it has been modified like the ADIOS to make it the third input-output medium of the system.

### 3. INSTRUCTIONS FOR USING THE IBM 026 AS AN INPUT-OUTPUT UNIT OF THE ADIOS SYSTEM

#### 3.1. Different automatic command signals

##### 3.1.1. For 231 R computers

ADIOS/026 Signals	Description	Corresponding IBM signals
CS	Computer selection order	2 6
No	Number of computer to be selected (ADIOS can select six)	same number
RT	Rate Test	6 7
PS	Pot set	=
ST	Static Test	2 4
IC	Initial Condition	(
HLD	Hold	)
OP	Operate	2 3

##### 3.1.2. For the ADIOS

CR	Reset output distributor and type- writer	*
RCY	Reset output distributor but not typewriter	/

[Table cont'd. on next page]

[Table cont'd.]

TAB	Tabulation	,
SET	Mode for pot set	
CHK	Mode for checking pot outputs	1 5
RD	Mode for static test (S.T.)	2 5
PC	Program Completed. STOP reader	.

3.1.3. For the IBM 026

Control Signals	Description
RAR 1.	Reader, automatic release 1
RAR 2.	Reader, automatic release 2
POFF	Punch, OFF

Only channels 1 to 7 control the computers and the ADIOS system.

Channels 12, 11 and 0 control only the IBM 026.

Channels 8 and 9 are not used.

3.2. Setting the potentiometers

The function of the first punched card is to prepare the analog computers and the ADIOS/026 system automatically.

This card will be punched in the following order:

Column	Signals
1	Blank
2	CR
3	CS
4	No
5	CR
6	PS
7	RCY
8	SET
9	CR
10	RAR 1

The other cards will be punched in the following manner:  
the potentiometer P00 should be set at the value 1248.

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Column	Signals
1	Blank
2	RCY
3	P
4	0

[Table cont'd. on next page]

[Table cont'd.]

Column	Signals
5	0
6	TAB
7	1
8	2
9	4
10	8
11	TAB
12	RAR 1

3.3. S.T. (Static test)

The first card again serves to prepare the machines.

Column	Signals
1	Blank
2	RCY
3	RD
4	RCY
5	ST

[Table cont'd. on next page]

[Table cont'd.]

Column	Signals
6	RCY
7	PC
8	RAR 1

The next to last signal is a Program Completed (PC) signal, which enables the operator to set the ADIOS system at Punch. (It is hoped that this operation can be made completely automatic within the next few weeks.)

After this step, the ADIOS is returned to START.

The following cards are made up of two cards in succession, one to interrogate the computer (Input), and one in which the computer punches the address and the required value (Output).

Example: What is the output value of amplifier A05?

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Column	Signals	
1	Blank	
2	A POFF	
3	0 POFF	
4	5 POFF	Computer
5	TAB POFF	input
6	TAB POFF	card
7 to 16	Blank	
17	RCY	
18	RAR 1	

The amplifier A05 has 7963 - as output value.

Column	Signals
1	Blank
2	RAR 1
3 to 5	Blank
6	A
7	0
8	5
9	TAB
10	7
11	9
12	6
13	3
14	-
15	Blank
16	RCY
17	RAR 2

Output  
card

An input card will always be followed by an output card. All of the output cards must first be punched in column 2 by a RAR 1 signal and in column 17 by a RAR 2 signal.

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3.4. It goes without saying that once the coefficients have been set

and the S.T. carried out, the ADIOS/IBM 026 can serve for the automatic control or checkout of a problem. A basic program of this kind has already been elaborated at CETIS/CANA. This includes cards capable of interrogating the 850 selectable outputs of the 231 R computers installed at CETIS.

On the basis of this program, a subprogram may be set up to fit each specific problem. This subprogram may then be used either to reform the outputs on the ADIOS typewriter at the end of each problem, or as a test routine each morning.

At CETIS/CADI, a code conversion routine for the IBM 1401 has been worked out to convert IBM codes to ADIOS code.

### 3.5. Manual controls

All the manual controls of the computers and the ADIOS system remain unaltered, but three new keys have been added.

Name of key	Type	Emplacement	Function
026 Normal/ APACHE	2 positions	ADIOS keyboard	<u>Normal.</u> IBM 026 becomes a normal punch. <u>APACHE.</u> It becomes an input-output unit in the ADIOS system.
Punch	3 positions	Keyboard	<u>ADIOS.</u> Only the ADIOS punch functions. <u>ADIOS/IBM 026.</u> The ADIOS punch and the IBM 026 punch both function. <u>IBM 026.</u> Only the 026 punch functions.
<u>Automatic release</u>	2 positions	Keyboard	<u>RAR 1</u> for a signal in channel 12. <u>RAR 2</u> for a signal in channel 11.

3.6. List of ADIOS codes punched on a card

Signals	Controls IBM 026			Controls ADIOS computers							Blank	
	12	11	0	1	2	3	4	5	6	7	8	9
0										X		
1				X						X		
2					X					X		
3				X	X					X		
4						X				X		
5				X		X				X		
6					X	X				X		
7				X	X	X				X		
8							X			X		
9				X			X			X		
A						X		X		X		
B							X	X		X		
C				X	X			X		X		
D							X		X	X		
E				X			X		X	X		
F					X			X		X		
G						X			X	X		
H					X	X	X		X	X		
I						X	X		X	X		

[Table cont'd. on next page]

[Table cont'd.]

Signals	Controls IBM 026			Controls ADIOS computers							Blank	
	12	11	0	1	2	3	4	5	6	7	8	9
J				X		X	X		X	X		
K				X	X		X		X	X		
L				X		X			X	X		
M				X				X		X		
N					X	X			X	X		
O				X	X	X	X		X	X		
P					X	X		X		X		
Q				X	X	X		X		X		
R								X		X		
S				X	X				X	X		
T				X		X		X		X		
U				X	X	X			X	X		
V				X			X	X		X		
W									X	X		
X				X					X	X		
Y					X				X	X		
Z					X		X		X	X		
CS					X	X			X	X		

[Table cont'd. on next page]



#### 4. THEORY

##### 4.1. Classification of schematics

Schematic No. 1. "231 R Expansion Group K 3 schematic E 002 04805" is a general schematic of the ADIOS system before modification. /19

Schematic No. 2. "IBM Wiring Diagram No. 4281101" represents all the wiring of the IBM 026 punch.

Schematic No. 3. "CETIS 004020" represents the entire circuitry of the IBM 026/ADIOS combination.

##### 4.2. Function of components (Fig. V)

4.2.1. Synchronization is achieved by the three relays RS1, RS2, RS3 in the upper left corner of schematic No. 3.

At time  $t_0$  a sequencing pulse from ADIOS energizes relay RS1,

at time  $t_1$  relay RS2 is energized as well as the punch clutch which commands the IBM 026 sequence,

at time  $t_2$  relay RS3 is energized and de-energizes relay RS1 for the duration of the pulse, thereby preventing the IBM 026 from recycling more than once during an ADIOS sequence,

at time  $t_3$  end of ADIOS pulse, de-energized.

##### 4.2.2. The IBM 026 card reader

Card reading is carried out by means of the inverters RI1 and RI2 and a buffer, shown on the left-hand side of schematic No. 3. Inverters RI1 and RI2 are energized by switching the APACHE key to "ON" and serve to disconnect the pin contacts of the punch magnets and connect them to the buffer. The buffer, Fig. 6 and 7, is a replica of the ADIOS card reader, the only difference being that it is actuated by relays instead of microswitches.

The buffer output is connected directly to the reader code relays.

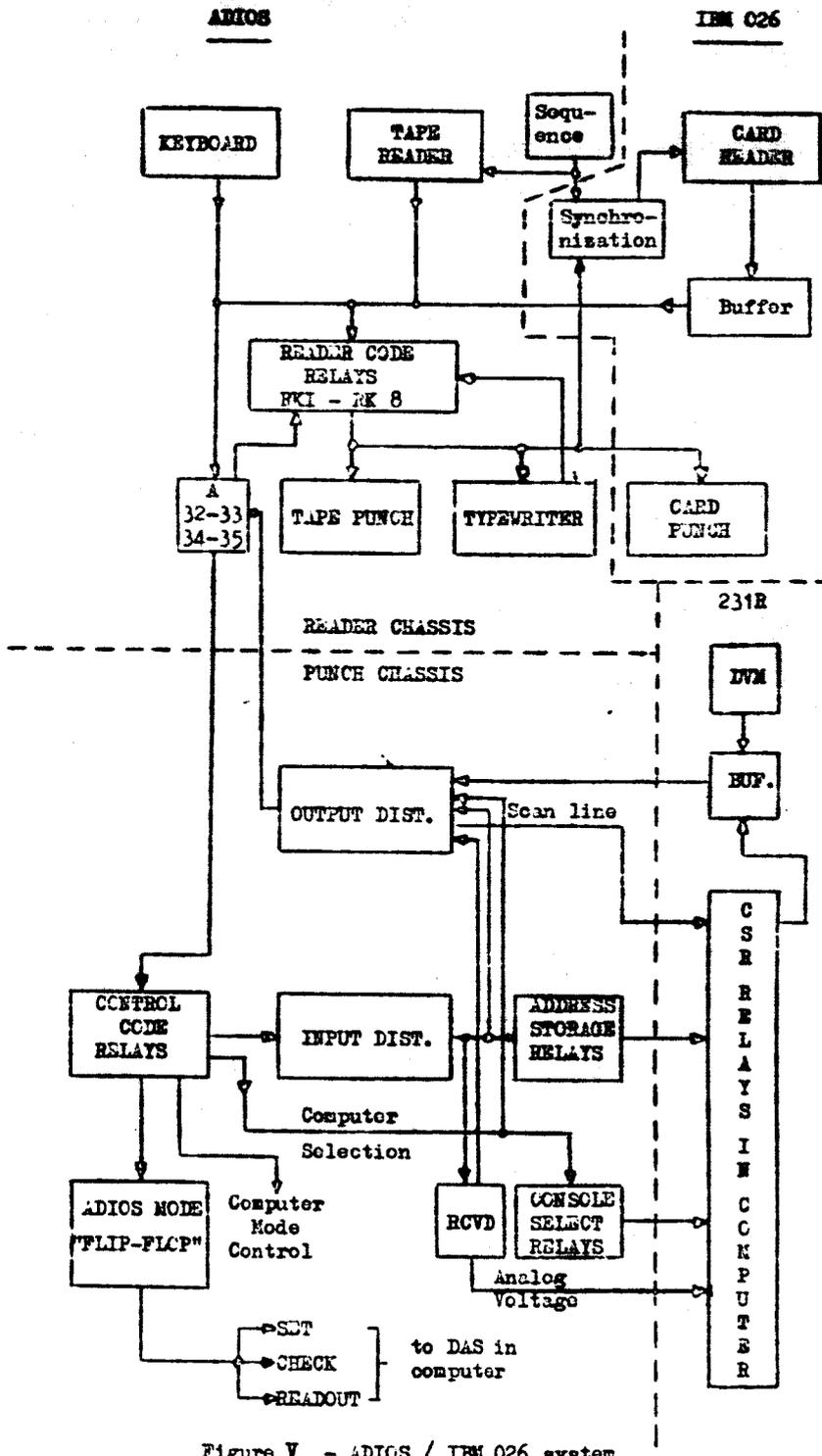


Figure V - ADIOS / IBM 026 system (Block Diagram)

#### 4.2.3. The reader code relays

1) RARR 1 reader automatic release relay is energized by a signal in channel 12 or 11 according to the position 1 or 2 respectively of the RAR key; the relay has the effect of energizing the release relay 1 and positioning a new punched card under the reader. /21

2) ASR 1 anti-stop relay. This relay prevents the reader from stopping in the middle of a cycle. If a stop signal is given during a sequence, the reader will stop just afterwards.

#### 4.2.4. IBM 026 Card Reader

Components: R<sup>40</sup> and R<sup>41</sup>, inverter relays installed in the ADIOS reader chassis.

RI<sup>3</sup>, interver relay installed in the IBM 026.

R1 to R11, 480 ohm resistance.

These are shown in the lower part of schematic No. 3.

Relays R<sup>40</sup>, R<sup>41</sup>, and RI<sup>3</sup> are energized when the Punch key is in the IBM 26 position. R<sup>40</sup> and R<sup>41</sup> make it possible to disconnect the ADIOS punch magnets logically. RI<sup>3</sup> makes it possible to connect the IBM 026 punch magnets in parallel with those of the ADIOS.

The ADIOS pulses having an amplitude of 115 V it became necessary to connect 480  $\Omega$  resistors in series with each IBM 026 punch magnet, in order to create a potential drop of  $\approx 50$  V, since these coils were designed to function in series with relay 56, the whole system being supplied with 130 V. Relay 56 is disconnected in the APACHE mode, since it can be used only with the normal IBM 026 printer.

#### 4.2.5. Card punch controls

1) The POFER Punch OFF Relay is energized during the read cycle to punch in the channel 0; it controls the relay RI<sup>3</sup> which then disconnects the IBM 026 punch magnets. /26

The function of the circuit is to prevent punching of a signal in the reading zone of the next card, which at that moment lies under the punch.

2) During the punching cycle, it is the PCM that controls the synchronization and no longer the reader RCC.

5. FUTURE PROJECTS5.1. Automatic division by ten when Check value exceeds 100 V (Fig. 10)

(Now in hand)

During the static testing of integrator input networks it often happens that this value exceeds 100 V, whereas the ADIOS can print only four figures, i.e., a maximum of 9999 V.

/27

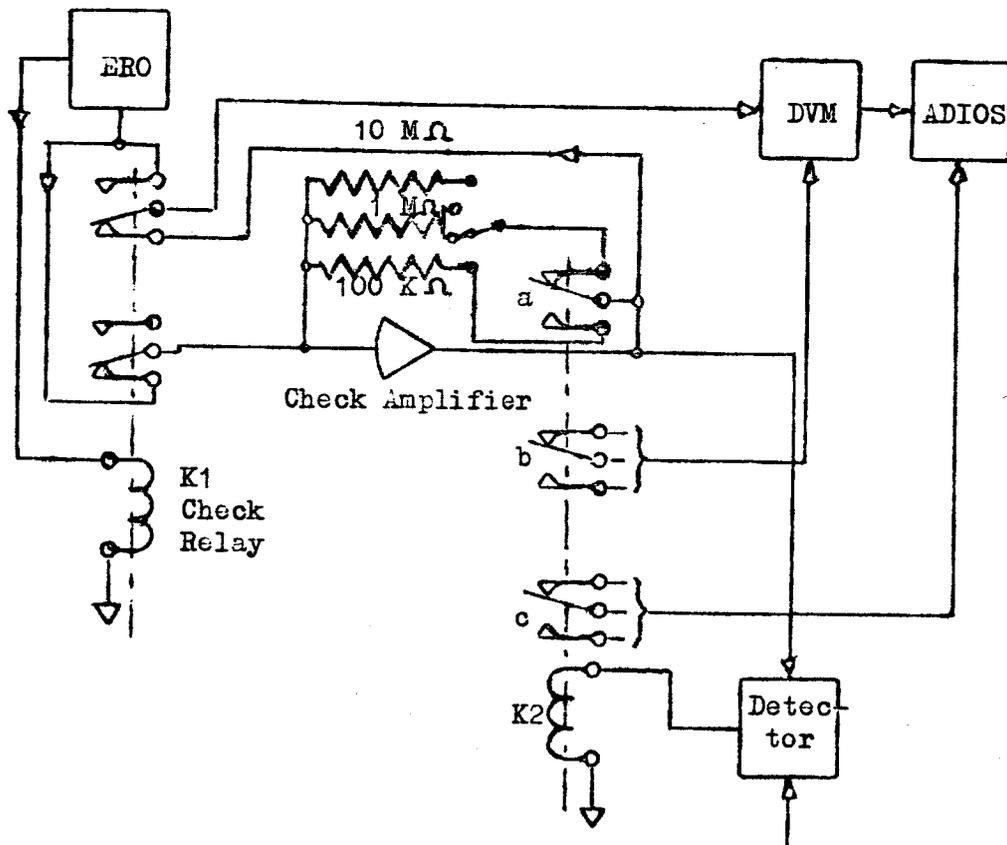


Fig. 10

Example: C05 is at 124.56 + V (the sign is placed after the value). ADIOS will punch 2456 + with no other comment and this will later be interpreted as 24.56 + V.

To remedy this, we are considering plans for a detector sufficiently sensitive to be able to energize a relay K2 when the value of the check amplifier output is between 99.99 and 99.97.

Contact a of relay K2 connects the 100 kilohm resistor in opposition to the amplifier and divides the input by ten; contact b displaces the decimal point on the DVM readout; contact c energizes the scale relay in the ADIOS which, after modification, will punch an E1 after the value read, i.e., in the preceding example we shall have 1245 + E1 and in APACHE language this will mean multiplying that value by ten.

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## 5.2. Automation of all remaining manual controls serving to prepare analog computers to accept ADIOS control signals

These control keys are installed on:

### 1) the computer

DVM switch  
TP of Mode control

### 2) the ADIOS system

Record  
Readout  
Punch Type

## 5.3. CRESSIDA II (Couplage REversible Statique Digital Analogue) [Static reversible digital analog coupling] [ref. 1]

This will make it possible to study the determination and organization of the input and output circuits of the ADIOS system, thereby opening the way for a direct approach to potentiometer setting and S.T. control without going through the punched cards.

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FARADAY TRANSLATIONS  
15 PARK ROW  
NEW YORK 38, N. Y.

APPENDIX OF CAPTIONS TO FIGURES NOT INCLUDED

Fig. 2. Lecteur = Reader; Perforateur = Punch.

Fig. 3.

Fig. 4.

Fig. 6. Buffer of IBM 026 reader, synchronization relays, inverters, control relays.

Fig. 7.

Fig. 8. Drawer type module of 50 automatic setting potentiometers.

Fig. 9. Reader Chassis of ADIOS.

Schematic Diagram No. 1

2

3